§32. IFE Reactor Chamber Wall Ablations with Intense Particle and Laser Beams

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The IFE reactor chamber walls are ablated with the high flux pulsed radiations of various kinds including photons and particles. It is very important to know the conditions in the IFE reactor chambers after these ablations. In the worst case, the produced mists of the wall materials remain at the chamber center and prevent the survival of the injected fuel targets. So that, in this article, we investigated how the candidate wall materials respond to (1) such intense particle beams (which are produced with the fusion implosions) and (2) such intense laser lights (which leak from the main laser driver lights to irradiate the fuel targets).

An intense pulsed proton source and an ArF laser were used to ablate various sample materials. The surface analyses after the beam irradiations were performed with various diagnostic tools in Institute of Laser Engineering, Osaka University and Department of Energy Sciences, Tokyo Institute of Technology.

The most recent results concerning these research works were published in the references [1-6]. The reference [5] was an invited paper, while [3] and [4] were reports as one of the members of the corresponding IAEA sub-committee.

Because of a super COE project (proposed by the other group in Tokyo Institute of Technology and accepted by the Ministry of Education, Culture, Science and Technology during this fiscal year, we evacuated from our co-use large facility area of about $300m^2$ before the end of this fiscal year. During this evacuation, we tried to reorganize our experimental facilities associated with our research subjects, and our pulsed power apparatuses were re-designed. We also discussed our future plan, under which our big machines are moved from Yokohama to NIFS (Toki), and a new five-year project is started to investigate the IFE chamber wall responses. Although this plan could not be realized, one of our medium size pulsed power system (pulsed ion beam machine called as “PICA-3”) was decided to be moved from Yokohama to Faculty of Engineering, Gunma University in the coming fiscal year.

Cryogenic pulsed ion diode was re-designed to produce intense He beam. Together with the proton beam, the He ion beam is useful to simulate the interaction between the beam and the chamber wall surfaces after the IFE implosion. Helium adsorption with an Ar or SF_6 surface over a cryogenic panel may become useful in our future works.

For the first time in this paper, the first author proposed a new type of Marx generator, as follows. The insulator oils for the conventional Marx generators up to now were mineral oils, which were more flammable and regulated under the law of fire-brigade stations. Under the present day law in Japan, oils with the flash points lower than 250 degree by Celsius are strictly regulated. If we use more than 2000 litter of oils, the facility space must have special restrictions under the law. In some case, we must prepare halon fire extinguisher systems. On the contrary, if we can use plant oils (which are not so flammable as the mineral oils and the flash points are higher than 250 degree by Celsius), the Marx generators can be installed in wider ranges of experimental site areas without such difficulties.

To realize a Marx generator with easier oil handling with plant oil, we investigated the electric breakdown voltage as a function of the electrode gap length, at first. One of our emerging results is shown elsewhere because of the page limitation, here.
The insulation endurance is enough high for this oil to be used as the insulating oil of a new Marx generator.

We are now preparing to operate a new pulsed-power system with this kind of new Marx generator. To suppress the oil degradation by the bulk oxidation, a new small inert gas supply system with a slightly higher pressure than the atmospheric pressure is also added to the new Marx generator.

References

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